SEMICONDUCTOR DISPLAY DEVICE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to an EL display that is formed by fabricating an EL (Electro Luminescence) element on a substrate. Particularly, the present invention relates to an active matrix type EL display that uses a semiconductor element (an element employing a semiconductor thin film), and furthermore to a semiconductor display device employing the EL display.

[0003] 2. Description of the Related Art

[0004] In recent years, technology for forming a TFT on a substrate has been largely improved, and an application development of the TFT to an active matrix type semiconductor display device has been carried out. In particular, the TFT using a polysilicon film has a higher electric field effect mobility than the TFT using a conventional amorphous silicon film, and therefore, the TFT may be operated at a high speed. Thus, the pixel control which has been conducted at a driver circuit outside of the substrate may be conducted at the driver circuit which is formed on the same substrate as the pixel.

[0005] Such an active matrix type semiconductor display device can, by preparing various circuits and elements on the same substrate, obtain various advantages such as a decrease in manufacturing cost, a decrease in the size of the semiconductor display device, an increase in yield, and a decrease in throughput.

[0006] Further, research on the active matrix type EL display having an EL element as a self-light-emitting element is becoming more and more active. The EL display is referred to as a light-emitting display, an organic EL display (OELD) or an organic light-emitting diode (OLED).

[0007] The EL display is a self-light-emitting type unlike a liquid crystal display device. The EL element is constituted such that a layer containing an organic compound (hereinafter, referred to as an EL layer) is sandwiched between a pair of electrodes (anode and cathode). However, the EL layer normally has a lamination structure. Typically, the lamination structure of a "hole transport layer/a light emitting layer/an electron transport layer" proposed by Tang et al. of the Eastman Kodak Company can be cited. This structure has a very high light-emitting efficiency, and this structure is adopted in almost all the EL displays which are currently subjected to research and development.

[0008] When the EL element obtains Luminescence (Electro Luminescence) which is generated by applying a voltage to the EL element, it is composed of an anode layer, an EL layer, and a cathode layer. There are two types of luminescence in an organic compound, one being a luminescence that is generated when the organic compound returns from a singlet excitation state to a ground state (fluorescence) and the other being a luminescence that is generated when the organic compound returns from a triplet excitation state to a ground state (phosphorescence). Either type of luminescence may be used in the EL display of the present invention.

[0009] In addition, the structure may be such that on the electrodes, a hole injection layer/a hole transport layer/a light emitting layer/an electron transport layer, or a hole injection layer/a hole transport layer/a light emitting layer/an electron transport layer/an electron injection layer may be laminated in order. Phosphorescent dye or the like may be doped into the light emitting layer.

[0010] In this specification, all the layers provided between a pair of electrodes are generally referred to as EL layers. Consequently, the hole injection layer, the hole transport layer, the light emitting layer, the electron transport layer, the electron injection layer and the like are all included in the EL layers.

[0011] In this specification, a light emitting element, which is composed of an anode, an EL layer and a cathode, is referred to as an EL element.

[0012] The deterioration of the EL material of the EL layer has become a problem in the realization of the EL display, which leads to the reduction in the luminance of the EL element.

[0013] The EL material of the EL layer is inferior to moisture, oxygen, light, and heat, which are the factors that promote the deterioration of the EL layer. To be more specific, the rate at which the EL layer deteriorates is influenced by the structure of a device driving the EL display, characteristics of the EL material structuring the EL layer, materials of an electrode, conditions of the manufacturing processes, a driving method of the EL display and the like.

[0014] The EL layer deteriorates even if a constant voltage from a pair of electrodes is applied thereto, whereby the luminance of the EL element is reduced. Thus, an image displayed on the EL display is not clear because of the reduction in the luminance of the EL element.

[0015] Further, Color display systems of the EL display are roughly divided into four: a system where three kinds of EL elements corresponding to R (red), G (green), and B (blue), respectively, are formed; a system where EL elements emitting white light are combined with a color filter; a system where EL elements emitting blue or blue-green light are combined with a fluophor (fluorescent color conversion layer: CCM); and a system where EL elements corresponding to R, G, and B are superimposed on a transparent electrode used as a cathode (an opposing electrode) (RGB stacking method).

[0016] The EL material that structures the EL layer differs depending on the luminescing color of the EL layer. Therefore, in the color display system that employs three kinds of El elements corresponding to the colors R (red), G (green), and B (blue), the three kinds of EL elements of the EL layer corresponding to RGB each may deteriorate at different rates. In this case, the luminance of the EL elements that correspond to RGB becomes dissimilar, respectively, as time passes. Consequently, an image having a desirable color cannot be displayed on the EL display.

SUMMARY OF THE INVENTION

[0017] The present invention has been made in view of the above, and therefore has an object to provide an EL display capable of performing a clear and desirable color display by suppressing a reduction in luminance of an EL element even if an EL layer is deteriorated.